

Cold Flow Circulating Fluidized Bed Testing Facility



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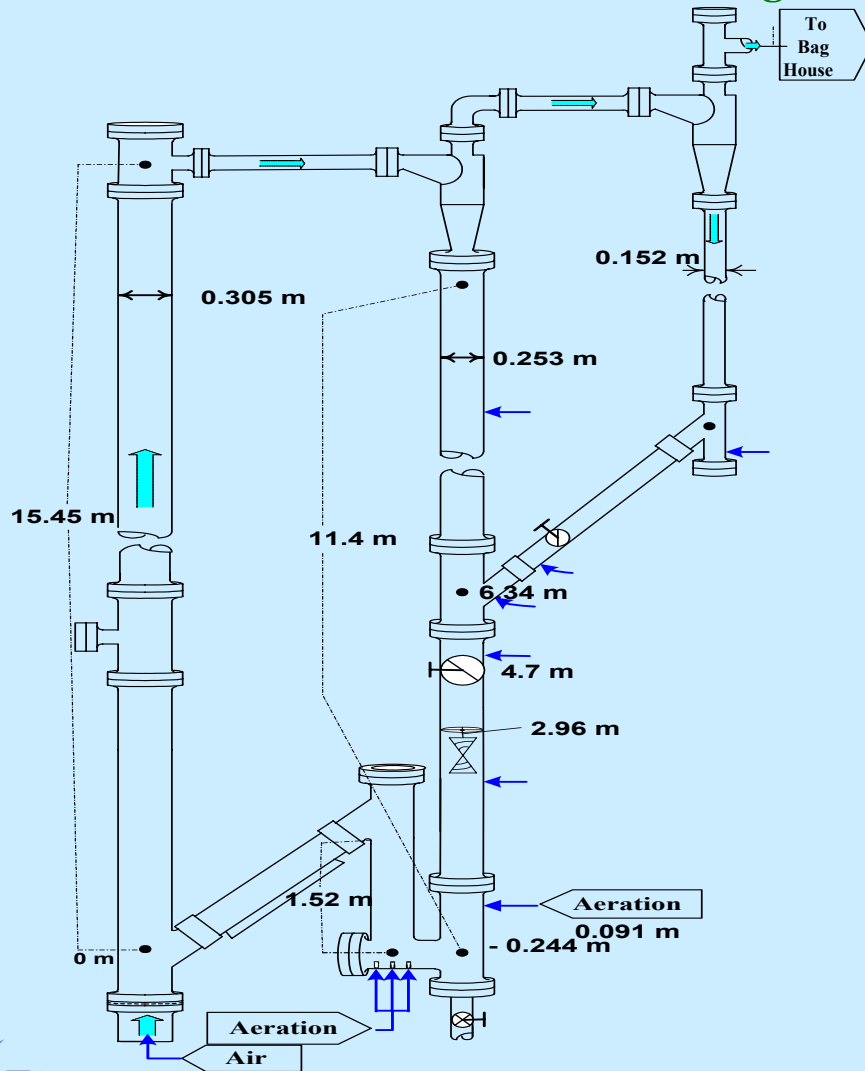
Objectives

- ☐ Emulate fully integrate operation of CFB systems to troubleshoot operational problems in gas-solid transferred through riser, standpipe, and non-mechanical valves
- ☐ Study operational principles of key gas-solid transport system componentss such as non-mechanical valves and standpipes
- ☐ Generate reliable data to validate mathematical and dynamic models currently being developed at DOE/NETL and provide data for stochastic and engineering models development
- ☐ Provide a platform for testing and development of advanced instrumentation to better characterize the internal flow behavior of a riser



Experimental Facility

0.3-m Diameter Circulating Fluidized Bed Cold Model



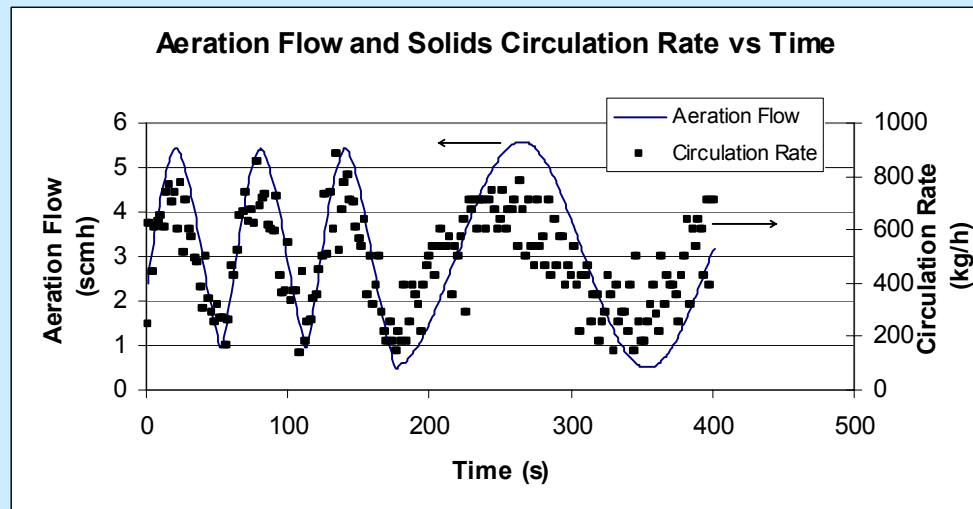
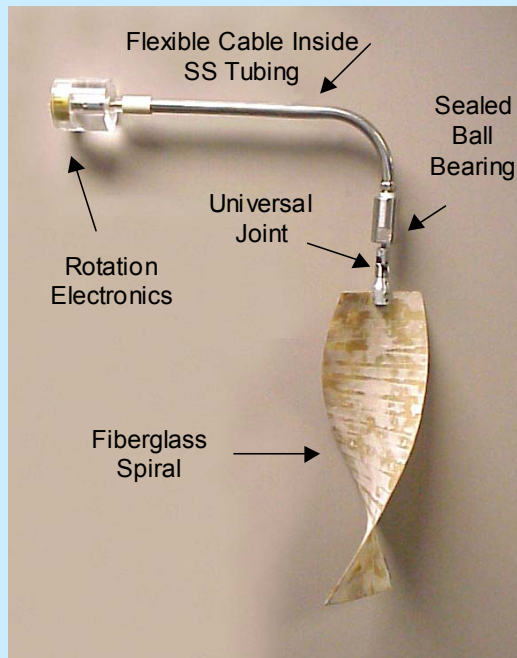
Research Instrumentation

□ Available Instruments

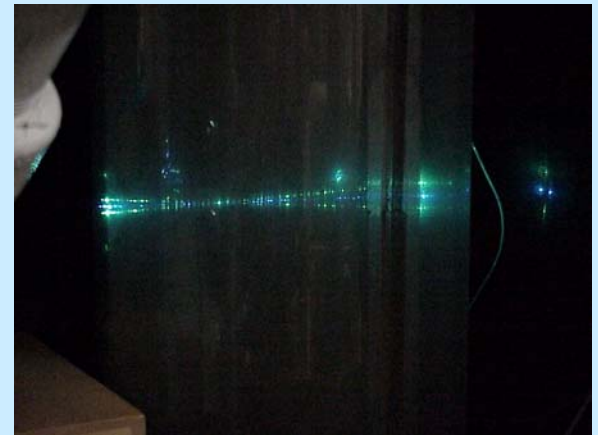
- Pressure Transmitters (differential pressure measurement)
- Solid Sampling Probes (solid flux measurement)
- Spiral Solid Flow Meter (solid circulation rate measurement)
- Vector Probe (particle velocity measurement)
- Laser Doppler Velocimeter (LDV) (particle velocity measurement near the riser wall)



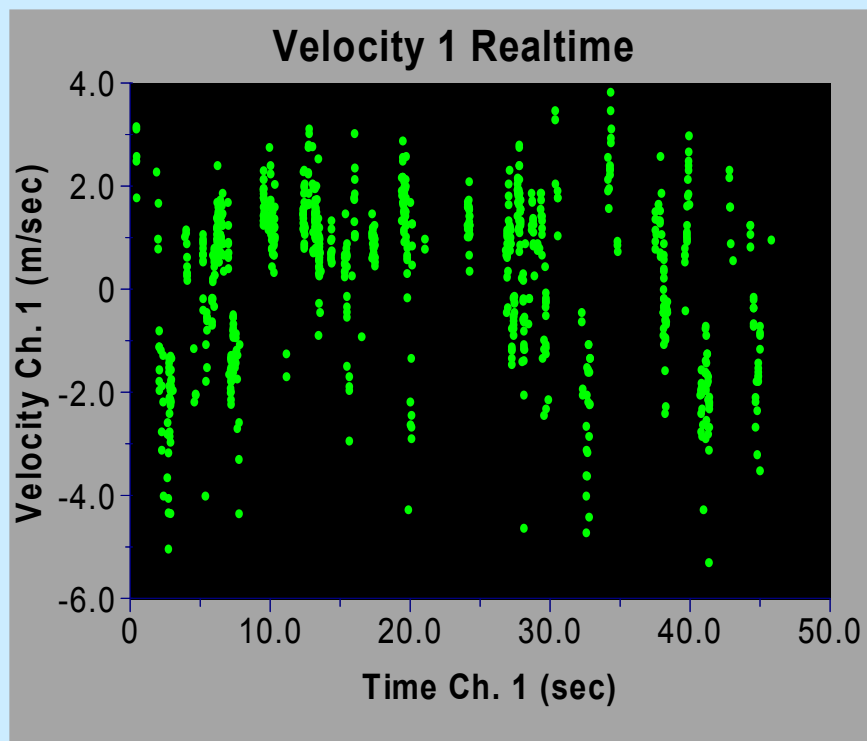
Spiral Solid Flow Meter



Laser Doppler Velocimeter (LDV)

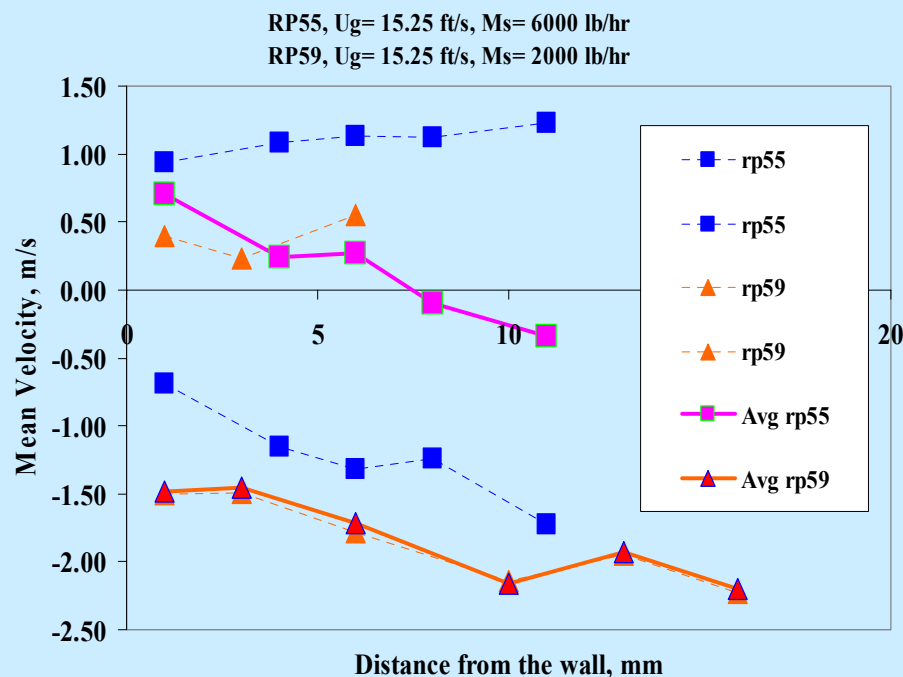


Laser Doppler Velocimeter Measurements



Dense flow- near wall

$U_g = 15.25$ ft/s, $M_s = 6000$ lb/hr



- Increasing circ. rate, decreases gas velocity near wall
- Upward flow velocity decreases
- Downward flow velocity increases.

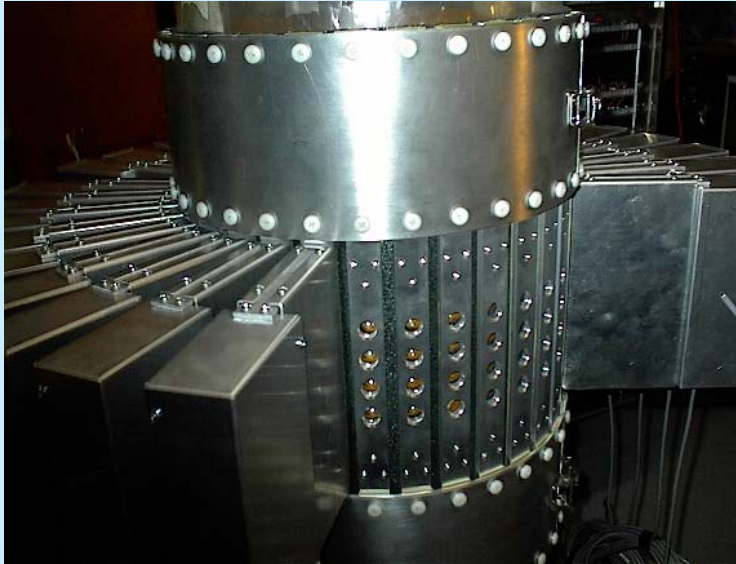
Research Instrumentation

□ Instruments Under Development

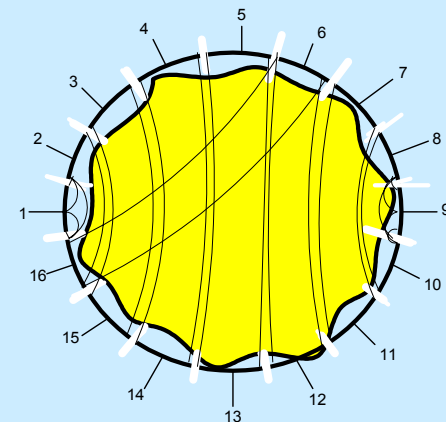
- Capacitance Imaging System
(solid/void fraction measurement)
- Shear Probe (wall shear stress measurement)
- Gas and Solids Mixing Techniques



Capacitance Imaging System



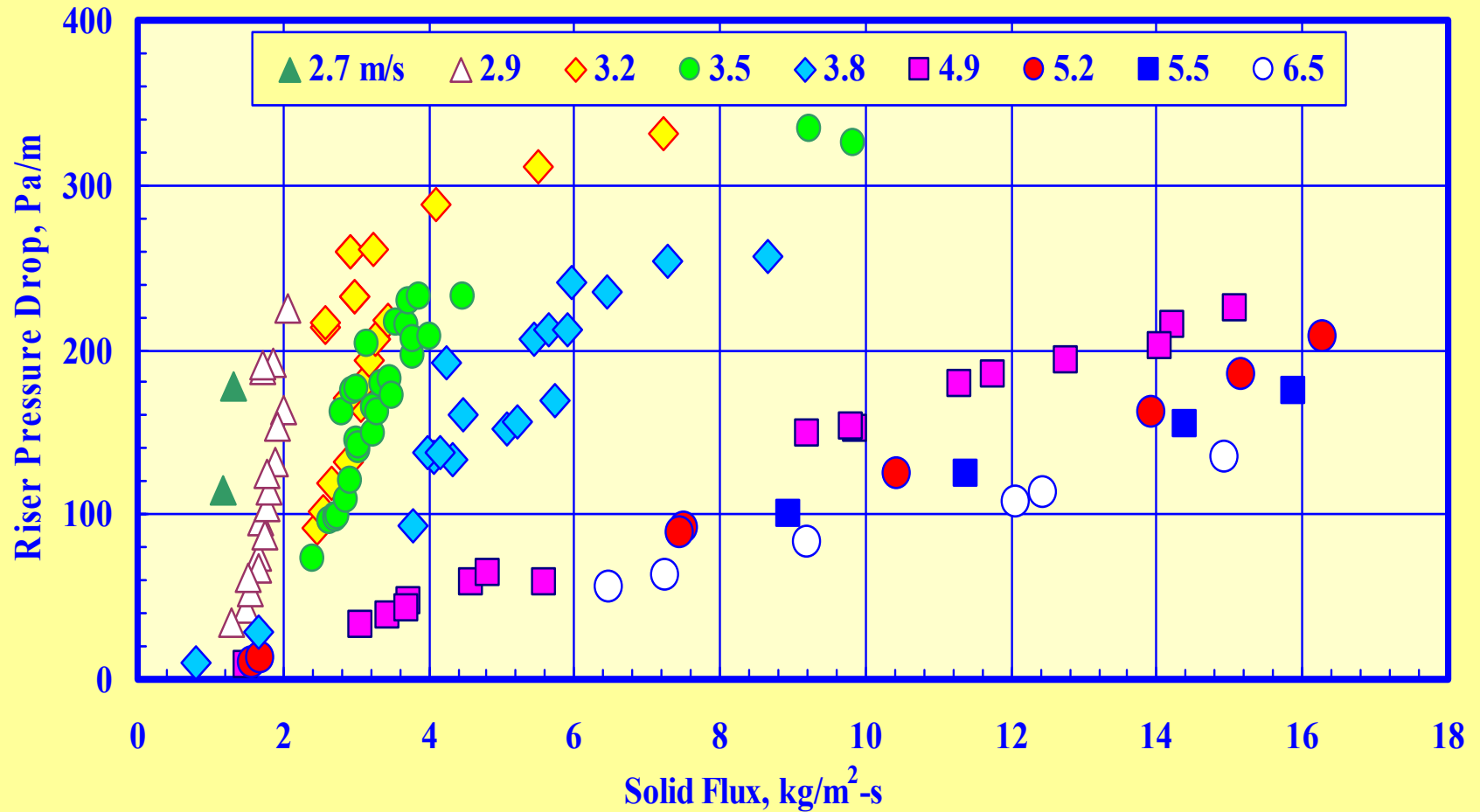
- ❑ 25,000 current measurements per second
- ❑ 400 current measurements per frame
- ❑ Approx 60 frames per second
- ❑ 40 micro-second measurement period (half of time used for transient recovery)
- ❑ Eight cycles of displacement current used for averaging for each point



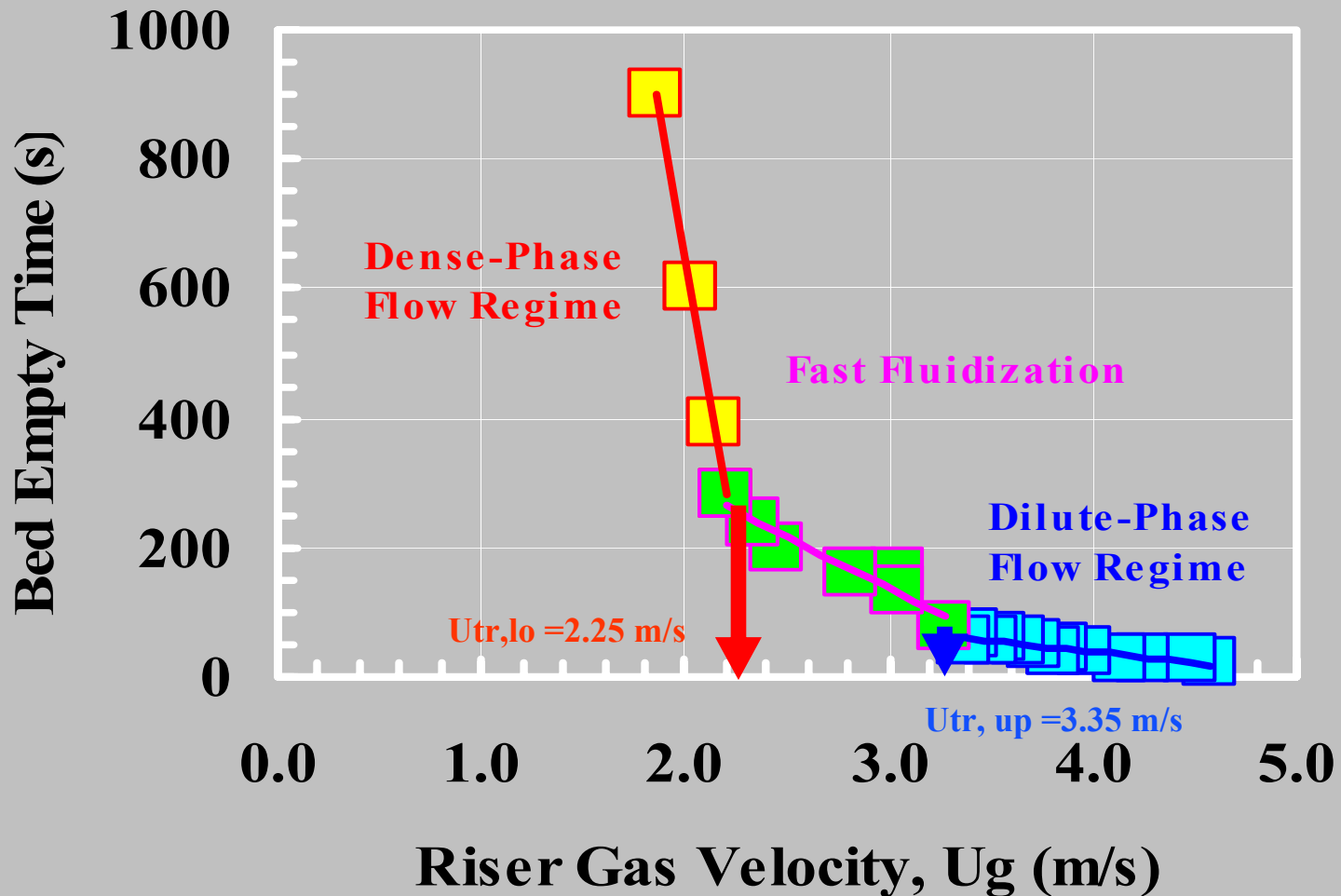
Experimental Results



Pressure Drop Across the Entire Riser as a Function of Solid Flux at Various Riser Gas Velocities

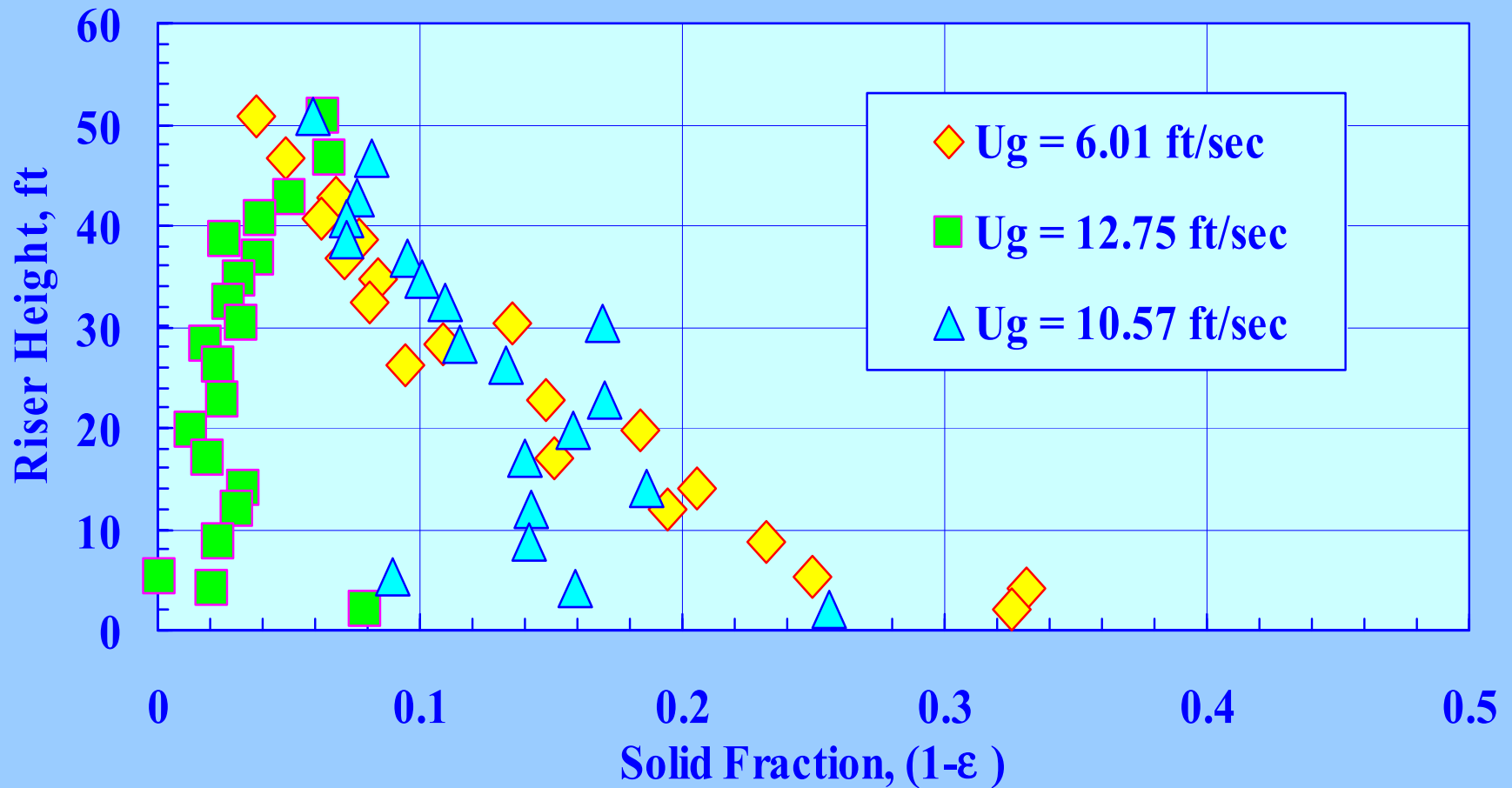


Upper and Lower Transport Velocity

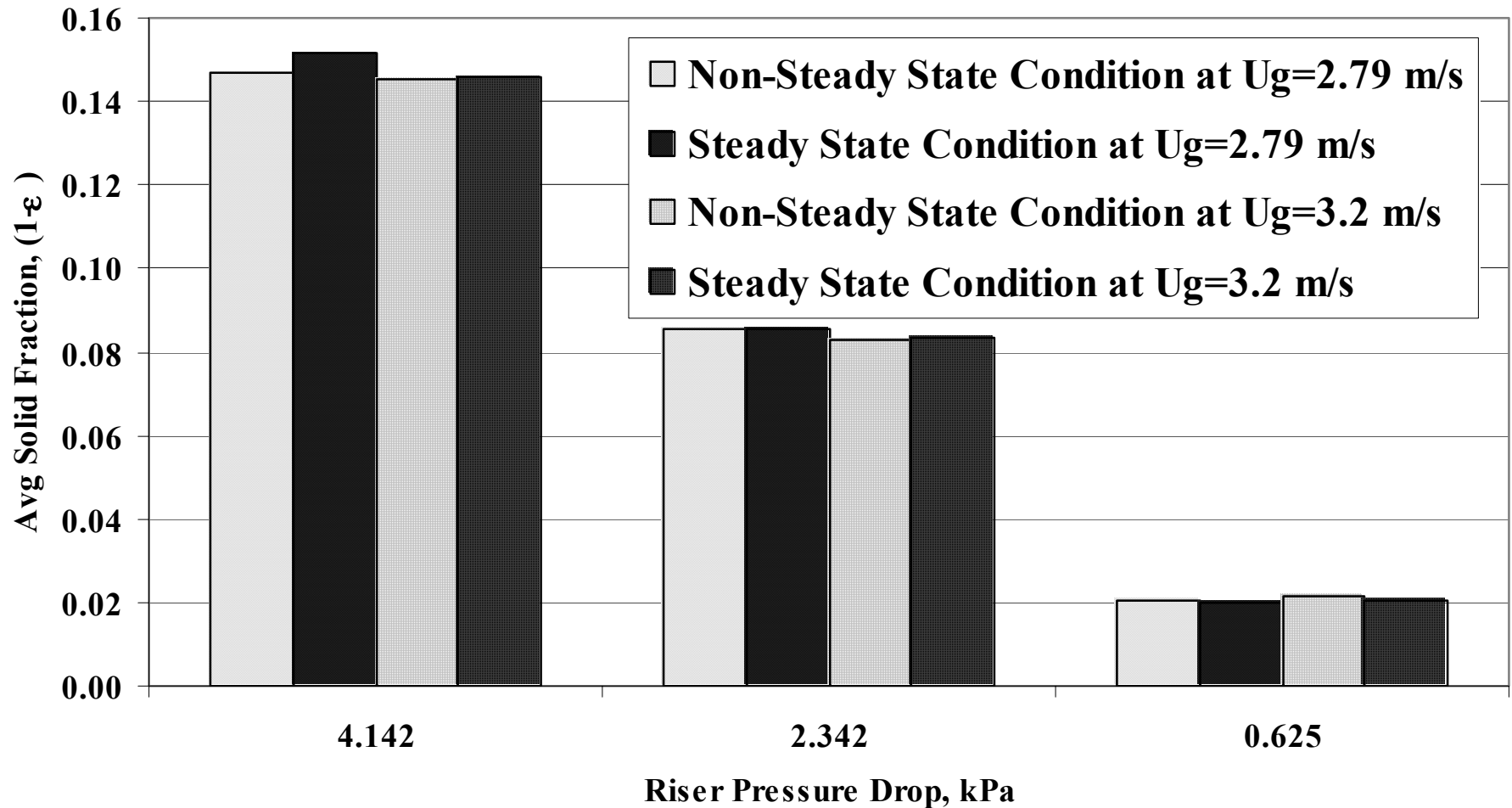


Riser Axial Solid Fraction Profiles at Different Flow Regimes

$M_s = 3,200 \text{ lbs/hr}$

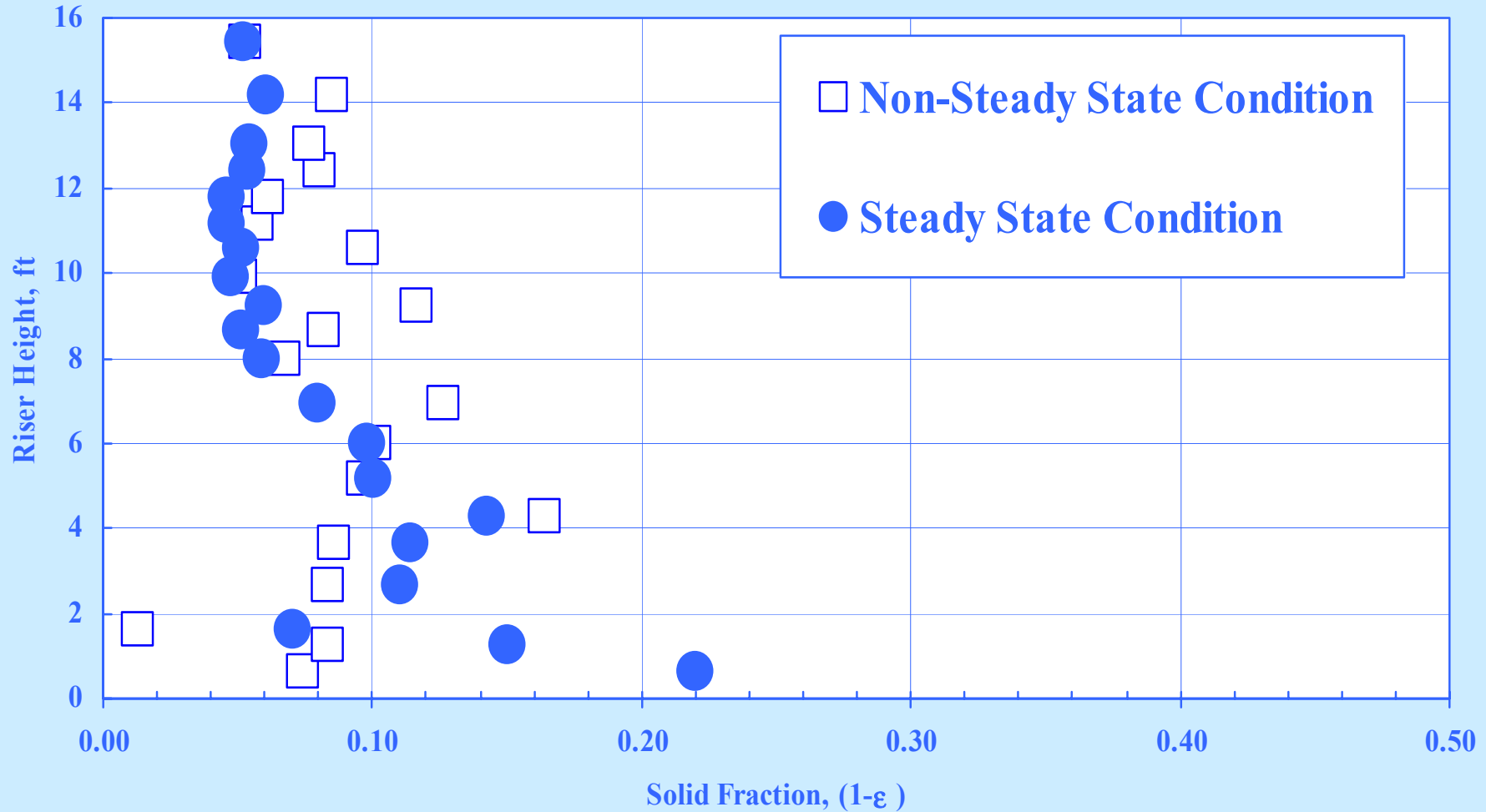


Comparison of Average Solid Fraction under Non-Steady State and Steady State Condition in a Riser



Solid Fraction Profile in Riser

$U_g = 3.2 \text{ m/s}$, $PDT811a = 2.34 \text{ kPa}$



Model Validation

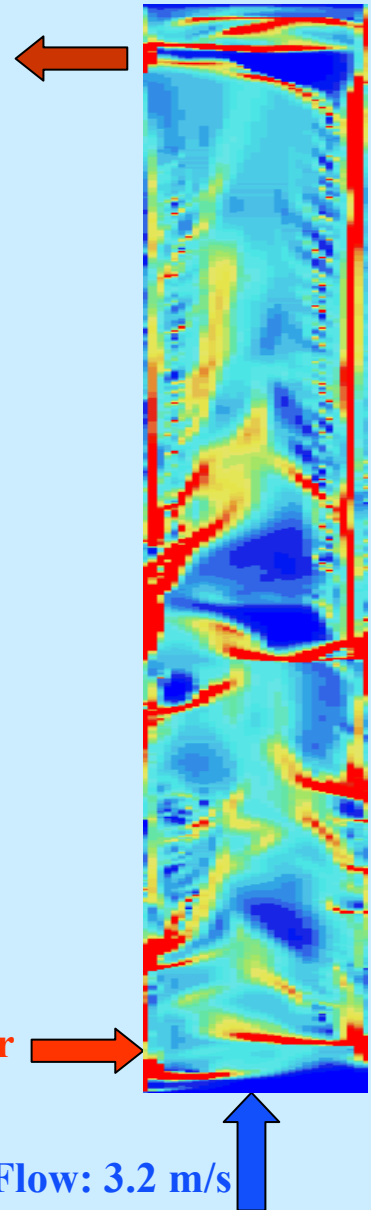


Model Validation

- ❑ Grid refinement (2-D) on small scale experiments
- ❑ 3-D Simulations on small scale experiments
- ❑ Minimum cell size (10x particle size)
- ❑ 2-D and 3-D simulations of NETL's CFB
- ❑ Simulation time needed to compare with SS tests data
- ❑ Parallel simulations on NETL clusters and PSC terascale
- ❑ Effect of flux limiters on pressure drop

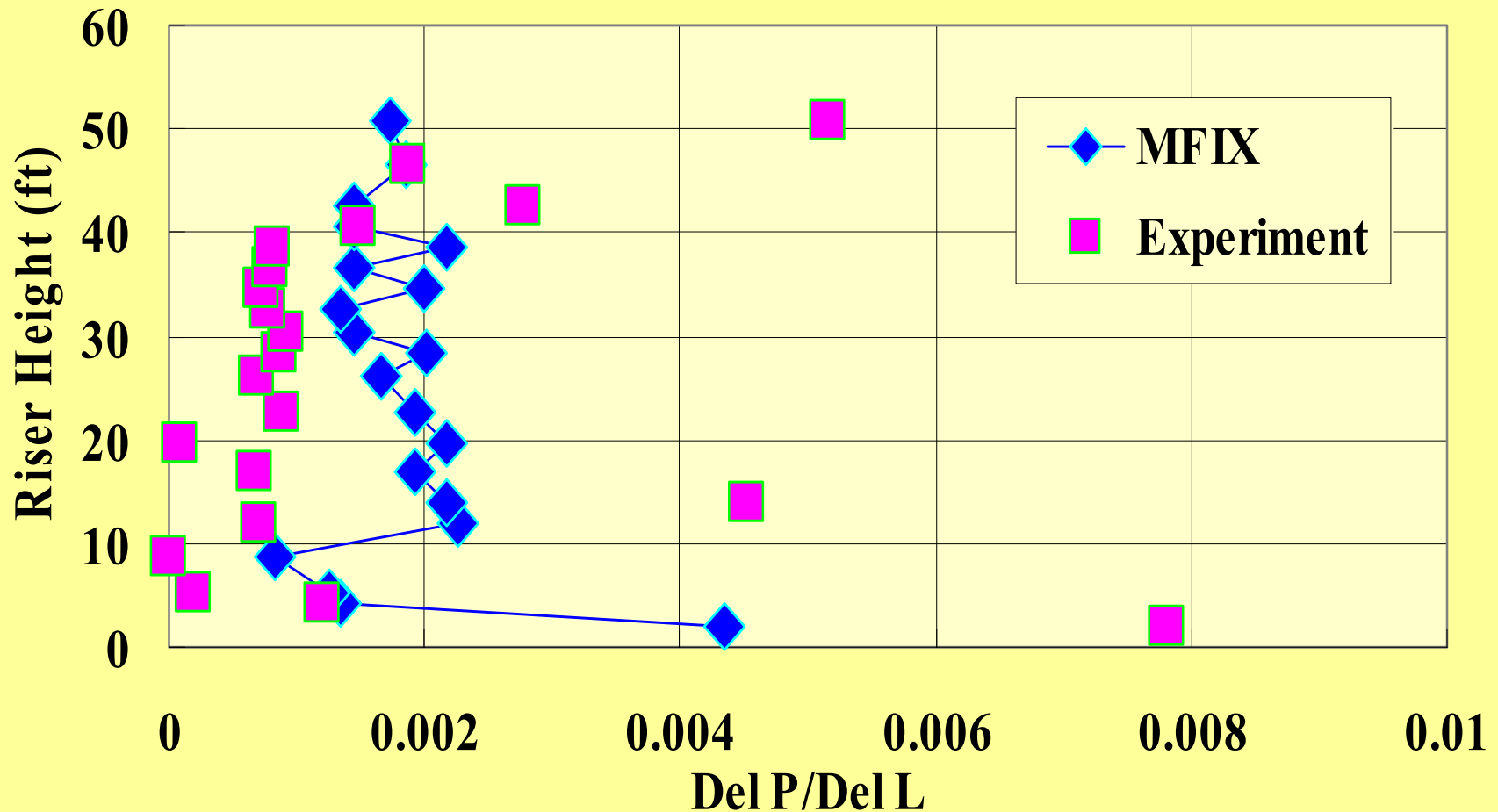
Cir. Rate: 4488 lbs/hr

Gas Flow: 3.2 m/s



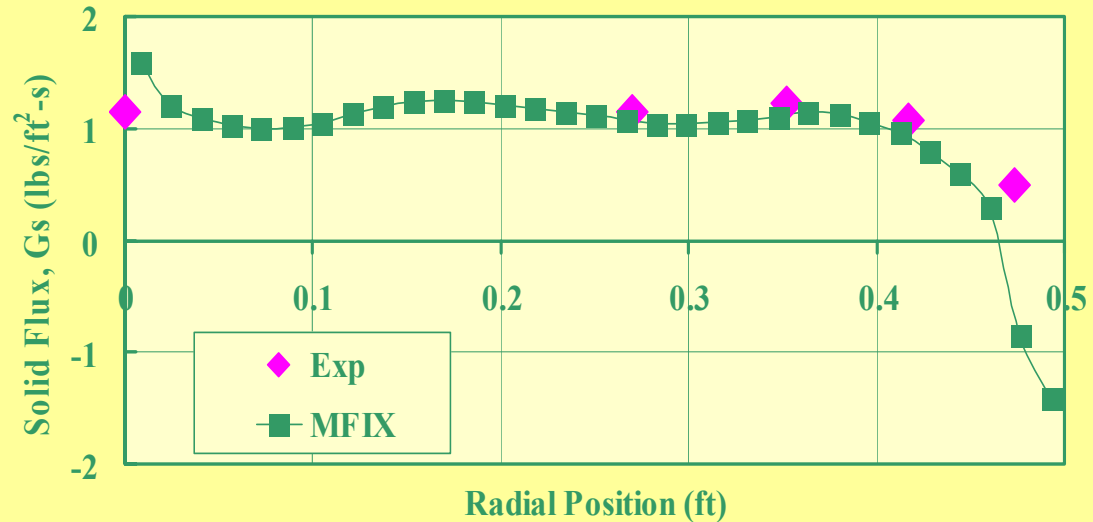
Comparison of Experimental Data with MFIx Predictions on Axial Pressure Profile

$U_g=17.25$ ft/s, $M_s=3172$ lbs/hr



Comparison of Experimental Data with MFIx Predictions on Radial Solid Flux

$U_g=17.25$, $M_s=3172$ lbs/hr



Comparison of Experimental Data with MFIX Predictions on Radial Solid Flux

$U_g=15.25$ ft/s. $M_s=2015$ lbs/hr

